817 PORTLAND CEMENT CONCRETE MIXTURES

817.01 PCC MIX DESIGN

(A) GENERAL. Concrete shall be proportioned within allowable tolerances of an approved mix design. An approved mix design shall consist of an approved concrete producer, materials sources, class of concrete, and material types and proportions. Mix designs for each project must be approved by the Engineer. Approval of a mix design for a specific project, purpose or use does not approve its use for any other project, purpose or use. Proposed mix designs may be a submittal category 1, 2 or 3 in conformance with Table 817.01-1.

Mix design information submitted shall have been obtained from measurements on a trial mix prepared with ingredients from the same source(s) as proposed for use. Mix designs shall have been prepared within 12 months prior to the date submitted. In the event such a mix design is not in full compliance with applicable specifications, further production of that PCC mix shall be suspended until an approved mix design has been obtained in accordance with these specification requirements. Any deviation from the approved mix design will require the approval of the Engineer.

Methods of proportioning mix designs shall be in conformance with ACI 211.1 for normal and heavy weight concrete, ACI 211.2 for lightweight concrete, and ACI 211.3 for no slump concrete.

Each PCC mix design submitted for approval shall include the following:

1. Name and Location of Project and Contract Number

2. Name and Address of Contractor

3. Name and Address of Concrete Producer

4. Mix Design Designation(s)

5. Class(es) of Concrete

6. Uses of Concrete

7. Source Name and Location of Fine Aggregate, Coarse Aggregate, Cement, Admixtures and Water.

8. Type of Cement

9. Cement Content in pounds per cubic yard of concrete

10. Saturated Surface Dry Weight of Coarse and Fine Aggregates in pound per cubic yard of concrete.

11. Water Content, including free moisture in the aggregate, plus water in the drum, exclusive of absorbed moisture.

12. Dosage of Admixture(s).

13. Sieve Analysis of Fine and Coarse Aggregate.

14. Absorption of Fine and Coarse Aggregate.

15. Bulk Specific Gravity (dry and SSD) of Fine and Coarse Aggregate.

16. Dry Rodded Unit Weight of Coarse Aggregate in pounds per cubic foot.

17. Fineness Modulus (FM) of Fine Aggregate.

18. Materials Certification for Cement, Admixtures and Aggregates.

19. Slump of Plastic Concrete in inches.

20. Air Content of Plastic Concrete in percent by volume.

21. Unit Weight of Plastic Concrete in pounds per cubic foot.

22. Seven Day Compressive Strength of Concrete in pounds per square inch.

23. Twenty-eight Day Compressive Strength of Concrete in pounds per square inch.

24. Whether the design is an Alternate Mix Design.

Up to 50 calendar days may be required for review of a proposed PCC mix design in Category 1 or 3 after it has been submitted for approval. In order to minimize the time between Notice to Proceed and completion of mix design reviews for Category 3 submittals, the apparently successful bidding Contractor may submit proposed mix designs for project approval at anytime after bid opening date. Review of alternate mix designs may require longer than 50 calendar days.

(B) ALTERNATE MIX DESIGNS. A mix design shall become an alternate mix design under any one of the conditions in Table 817.01-2.

Table 817.01-2

SUBMITTAL CATEGORY	ALTERNATE MIX DESIGN CRITERIA
1	Producer has previously made a Category 1 submittal for the same class of concrete.
2	Proposed producer has made a Category 1 submittal for the same class of concrete.
2 & 3	For the same class of concrete, more than one producer is proposed.

(C) PROPORTIONS. Concrete mixtures shall be proportioned so as to secure a workable, homogeneous, placeable mixture which meets the requirements of 817.03 for its intended use. The concrete shall be proportioned by weight and shall consist of portland cement, fine aggregate, coarse aggregate, water, admixture(s) and other ingredients as may be specified. Unless specified otherwise, strength values are the average of two companion test cylinders.

Minimum average strength requirements will be determined per ACI 214. A probability of not more than 1 in 10 tests falling below the specified strength will be used to compute the minimum average strength for the following conditions.

(1) When past performance records are available: The documented performance records of the producer consisting of at least 30 consecutive 28 day strength tests for the same class of concrete used within the last year will be used to establish a coefficient of variation. The required average strength will be determined on the basis of the computed coefficient of variation.

(2) When past performance records are not available, a coefficient of variation of 15 percent will be used to compute the minimum average strength.

The strength of no individual cylinder shall be less than 85 percent of the minimum compressive strength in 817.03.

In no case shall the cement content be less than that in 817.03. An approved water reducing admixture shall be furnished and incorporated into the concrete when necessary to provide the required slump without exceeding the maximum water-cement ratio.

Mix design proportions shall be adjusted by the Engineer when the concrete requirements of 817 are not achieved when batched within the tolerances of any or all proportions.

All tolerances for measurement of materials will be applied to the approved mix design quantities. Tolerances for proportioning are as follows:

Material	**Tolerance, Percent by Weight of Mix Design**
Cement	+4,-0
Coarse Aggregate	± 2
Fine Aggregate	± 2
Water	± 1
Admixtures	± 3

817.02 MATERIALS

Portland Cement - 801.01
Portland Blast Furnace Slag Cement - 821.08
Masonry Cement - 801.02
Fly Ash - 821.09(B)
Fine Aggregate
1. Normal Weight - 803.01

2. Light Weight - 803.07
Coarse Aggregate
1. Normal Weight - 803.02
2. Light Weight - 803.07
Admixtures
1. Air Entraining - 814.04
2. Chemical - 814.05
3. Color - 814.06
Water - 821.01
Granulated Slag - 821.08
Formulated Latex Modifier - 821.17

817.03 DESIGN CRITERIA

Proportions of concrete shall be such that the design criteria herein are met for the respective class of concrete.

(A) CLASSES OF CONCRETE. Unless otherwise specified, the following classes of concrete shall be used.

CLASS	DESIGNATION	USES
A	Structural Trap Rock	Bridge Decks, sidewalks, and medians for superstructures. Suitable for all uses specified for Class B, Structural.
B	Structural	Reinforced structures, footings, slabs, approach slabs, beams, girders, columns, piers, abutments, walls, arch ribs, box culverts, precast piles, traffic barriers, and cribbing. Sewer and water work except thrust blocks and pipe cradle.
C	High Early Strength	For special and emergency uses as approved by the Engineer.
D	Prestressed	Used for prestressed or post tensioned members.
E	Paving	Alleys, alley and driveway entrances, curbs and gutters, pavements and base.
F	General	For general use and in sidewalks, curb, and gutter, bike paths or as specified.
H	Lightweight	As specified.
I	Low Slump	As specified.
J	Latex Modified	As specified.

(B) DESIGN REQUIREMENTS. Granulated slag may be used in an amount not to exceed 40 percent by weight of cement. Cement factor and water-cement ratio is determined on basis of combined granulated slag and cement weight.

Fly ash and granulated slag may not be used in the same mixture.

a. The Engineer may approve, pending 28 day strength results, mix designs on the basis that 7 day compressive strength results equal or exceed 85 percent of the minimum average strength requirement as determined in 817.01(C) provided no accelerators or early strength cements are used.

b. Crushed traprock per 803.02 shall be used in Class 1 concrete if used in concrete for bridge deck, sidewalk and median of superstructures.

c. Consistency limits are those allowable with water. A maximum slump as limited by the mix design will be allowed for concrete approved with water reducing admixtures.

d. Fine aggregate shall conform to 803.01.

e. Fine aggregate shall conform to 803.07.

f. Latex emulsion conforming to 821.17 shall be added in an amount of 3.5 gallons per sack of cement.The latex will weigh approximately 8.40 to 8.55 pounds per gallon.

Proportions of cement to fine aggregate to coarse aggregate on a dry weight basis shall be 1 to 2.5 to 2.0 with a tolerance of 10 percent on the fine and coarse aggregate ratios.

g. Latex emulsion is included as part of the maximum water.

h. Fly ash may be substituted for cement such that not more than 15 percent by weight of cement is removed. The mix may require more fly ash added than cement removed. Cement factor and water-cement ratio determined on basis of combined fly ash and cement weight. Fly ash shall conform to the requirements of 821.09(B).

(C) PROTECTION OF CONCRETE AGAINST ALKALI REACTIVITY

Fine and coarse aggregates for use in concrete that will subject to wetting, extended exposure to humid atmospheric conditions or contact with moist ground shall not contain any material that is deleteriously reactive with alkalies in the cement in an amount sufficient to cause excessive expansion of mortar or concrete, except that if such materials are present in injurious amounts, the fine and coarse aggregates may be used with a cement containing less than 0.6 percent alkalies calculated as sodium oxide or with the addition of a material that has been shown to prevent harmful expansion due to the alkali-aggregate reaction.

When the concrete will be subjected to external sources of alkalis and/or chlorides, the aggregates used shall not contain more than 3 percent reactive constituents as defined by ASTM C 295, and pass at least one of the following criteria as may be applicable in accordance with ASTM C289, C 227, C 586, C 9 and P 214.

817.04 DESIGN ADJUSTMENTS

The concrete strength level of an individual class of concrete (specified in Table 817.03 shall be considered satisfactory if both the following requirements are met:

(1) The average of all sets of three consecutive strength tests equal or exceed the minimum strength.

(2) No individual strength test (average of two cylinders) falls below the minimum strength by more than 500 psi.

If concrete produced has a lower average strength or a higher coefficient of variation than anticipated, the mix design proportions may be adjusted by the Engineer at no additional cost to the District.

The mix design will be reviewed and revised as necessary when the producer changes the sources of material from those of the approved mix design; or when the fineness modules of the fine aggregate changes by more than 0.20 from the mix design.

Concrete mix design can be revised to improve placement during cold, hot or unusual weather as long as the requirements of 803 are met and the revision is approved by the Engineer.

When sources of materials change from those of the approved mix design or when the fineness modulus of the fine aggregate changes by more than 0.20 from the mix design, the mix design will be reviewed and may require a new design.

In the event concrete with the required workability or consistency can not be obtained within the maximum water cement ratio with the materials furnished by the Contractor or producer, changes shall be made as necessary to secure the desired properties subject to the requirements of 817 and the approval of the Engineer.

817.05 CONSTRUCTION METHODS.

Aggregates and portland cement shall be proportioned by weight; water may be proportioned by volume or by weight. Batch weights of aggregates for the concrete shall be corrected for free moisture, as calculated from moisture determination performed by the Contractor and witnessed by the Engineer; these moisture determinations shall be made as frequently as deemed necessary by the Engineer. PCC consistency shall be checked in accordance with 501.05.

The approved mix design shall not be changed except as provided below:

(1) Adjustment for variation in finesses modules (FM). If the FM of the fine aggregate exceeds the limits specified in 803.01, the mix design shall be adjusted as provided in 817.04.

(2) Adjustment for variation in workability. If it is impossible to obtain PCC of the desired workability with proportions approved by the Engineer, the Contractor shall make such changes in aggregate weights as necessary, provided that in no case shall the cement content originally designated be changed except as provided below.

(3) Adjustment for variation in yield. If cement content of the PCC determined by AASHTO T 121 varies more than plus or minus 2% from the approved mix design, the proportions shall be adjusted by the Contractor and approved by the Engineer to maintain a cement content within these limits. The water content shall not exceed the maximum approved.

(4) Adjustments for new materials. Change in source or character of the materials shall be made only after tests on trial mixes and with the Engineer's written approval.